Quantifying Extreme Precipitation Events Based on Resolved Atmospheric Change

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Significance of the Proposed Project

One of the primary hazardous impact of climate change is possible shifts in the extremes of regional water cycle, especially changes in patterns, intensity and/or frequency of extreme precipitation events. Such extreme events are among the major pathways through which climate change will impact society. Unknown changes in extreme precipitation events are particularly important because they can lead to catastrophic losses, particularly due to the difficulty developing adaptive strategies under such uncertainty.

Objectives of the Study

❖ To address a key question of global change research – will extreme precipitation and/or flood regimes change in the future, and what and where are the impacts?

❖ To quantify the potential changes of extreme precipitation and flood events.

❖ To ultimately achieve an improved capability to predict changes in precipitation extremes under future climate change.

Data and Methods

Scientific Basis:

❖ Extreme precipitation often results from the interaction of large-scale atmospheric features (moisture-flow fields and dynamical instabilities) and local phenomena (such as terrain and other surface features) that cannot be "resolved" in climate models.

❖ Climate models are unable to collectively convey credible projections of change in the statistics of extreme precipitation.

Hypothesis: Large-scale atmospheric patterns as simulated by climate models can provide a valuable complement toward assessing potential trends in precipitation extremes than simulated precipitation alone.

Methodology: To use historical data to develop synoptic analogues for the dependence of extreme precipitation (i.e. flood risk on the climate regime) and then use such analogues to process large-scale fields as simulated by climate models with global change forcing.

Data Set:

	Temporal span	Spatial domain	Source
Precipitation observations	1948-2002 (hourly)	ungridded	CPC
MERRA reanalysis atmospheric diagnostics	1979-present (3 hourly)	Global (1.25°)	NASA
Climate model simulations	variable	Global (variable)	IPCC AR4 archive

Analyses Task

❖ Characterize the statistical nature of observed precipitation events.

❖ Identify (by a composite approach) the synoptic conditions from the geophysical fields of the reanalysis that support local precipitation extremes.

❖ Use the observationally based climate regime synoptic analogues of precipitation extreme to estimate changes in the probability of extreme events.

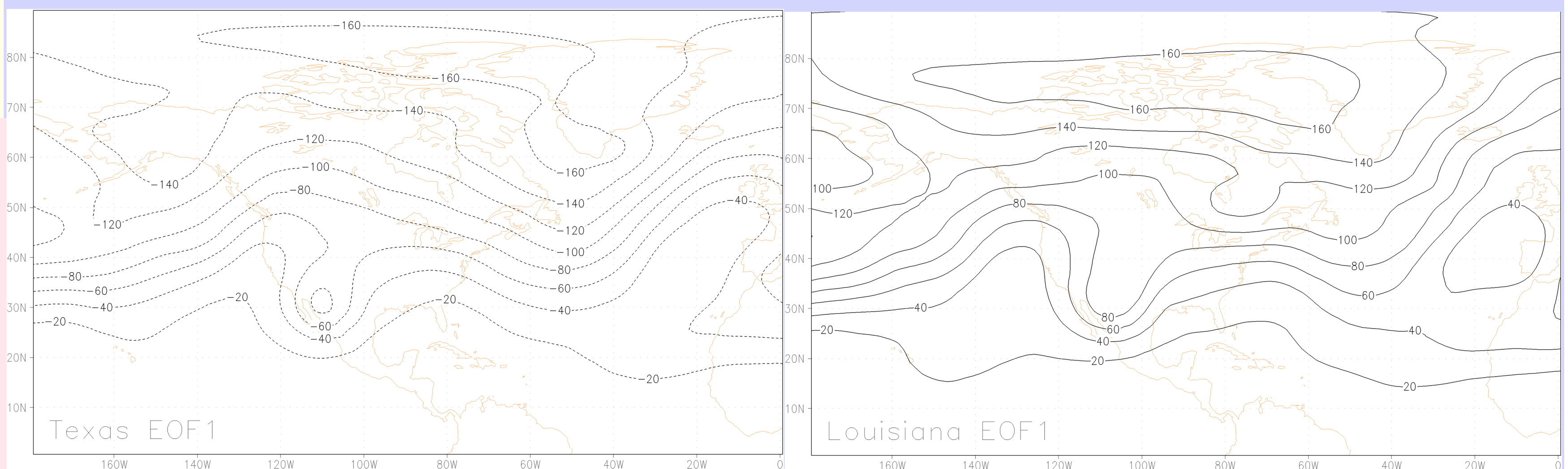
Study Cases (South-Central U.S. – Texas and Louisiana)

We extract extreme values at four times the number of years of daily precipitation events from each station, compile the extracted extreme events from all stations of a particular state, and then select the days with the stations reporting not less than 25% (spatial coverage dominance). EOF analysis are performed for the times series of MERRA 500mb geopotential height with the days corresponding to the filtered observed precipitation extremes. We also construct the seasonal composite of MERRA 500mb geopotential height.

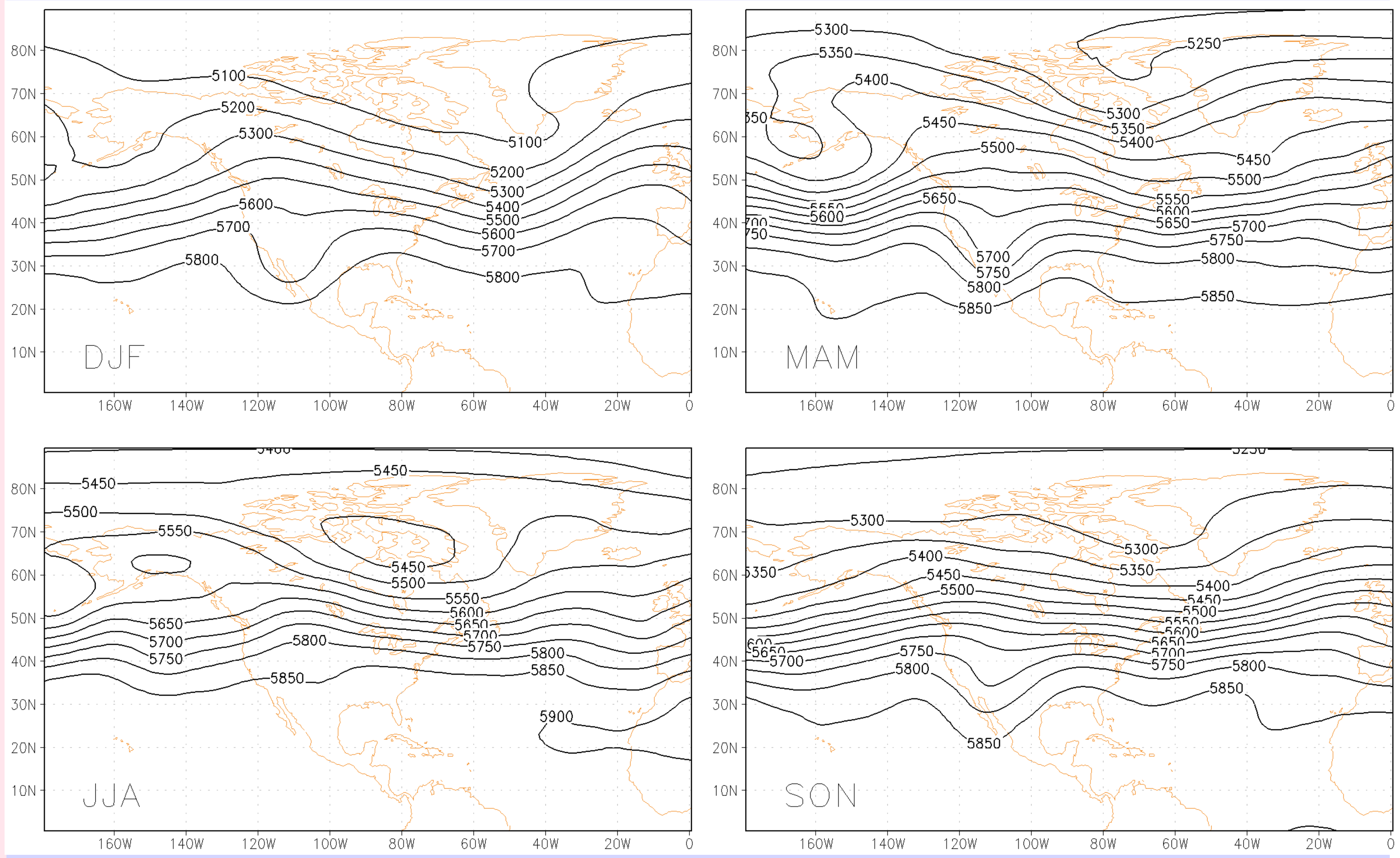
Variance% explained by 6 leading EOF

State	EOF1	EOF2	EOF3	EOF4	EOF5	EOF6	SUM
TX	56.3	7.4	5.2	4.0	3.7	2.6	79.2
LA	54.2	7.1	5.9	4.9	3.9	3.0	79.0

The 1st leading EOF of TX and LA MERRA 500mb geopotential height convey consistent dynamic pattern that there is a trough -like feature just upstream from Texas or Louisiana.



Seasonal composite of TX MERRA 500mb geopotential height



Future Work

❖ Refine the analysis strategy for extracting the observed precipitation extreme events – emphasize the spatial coverage dominance or persistence/intensity dominance.

❖ Expand climate analogue composites to consider other geophysical (e.g. surface pressure and convergence) and thermodynamic (e.g. moist static energy) fields.

❖ Refine the geophysical/thermodynamic composites associated with observed precipitation extremes – construct anomaly composites and test the implementation of these climate analogues with GCM simulated fields.

❖ Expand the analysis to various major sub-continental domains of the U.S. (i.e. Northeast, Southeast, Midwest, Southwest, and Northwest) to regionalize the analogues.

❖Perform the climate analogue assessment of potential changes in extreme precipitation for IPCC SRES AR4 archives.